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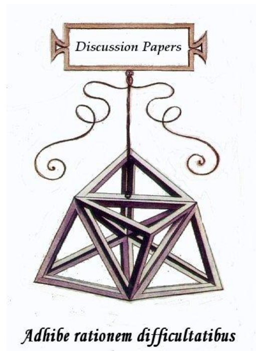

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Pension funds and Stock Market Volatility: An Empirical Analysis of OECD countries.

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Discussion Paper
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Pension funds and Stock Market Volatility: An Empirical Analysis of OECD Countries

Abstract

The paper explores the empirical relationship between the share of pension funds' assets invested in stocks and stock market volatility in OECD markets. For this purpose, by using panel data of 34 OECD countries from 2000 to 2010, we estimate both a random effects panel model and a Prais-Winsten regression with panel corrected standard errors and autoregressive errors. The econometric estimation documents that there is a significant negative relationship between the share of pension funds assets invested in stocks and stock market volatility in OECD markets. The binary Probit and Logit models further validate the argument that pension funds as institutional investors can dampen stock market volatility.

Classificazione JEL: G23, G14, C23
Keywords: *Pension funds, Stock market volatility, Panel data*

1 Introduction

Pension funds (PF henceforth) have accumulated large amounts of assets over the years in most of the OECD countries (see Table 1). With increasing ageing population and less reliance on pay-as-you-go public pensions, in many developed economies the size of complementary social security is expected to increase even further in the future.

The shift from the traditional defined benefit (DB) scheme to the defined contribution scheme (DC) since the early 2000s is one of the main features characterizing the recent growth path of PF. Such a shift has been primarily originated by the dramatic changes both in the industrial structure and in the labor markets triggered by the globalisation, which has led both capital and workforce to be increasingly mobile. As a consequence, many countries have implemented reforms aiming at coping with the deterioration in the funding of DB pension plans and with some longstanding concerns regarding the effect of complex, opaque pension accounting methods.

Table 1: Assets managed by PF as a share of GDP of selected OECD countries over the period from 2000 to 2010, selected years (% values).

Country	2001	2005	2008	2010
Australia	75.29	80.38	93.008	90.94
Canada	52.48	58.15	51.43	64.65
Chile	-	59.35	52.76	66.97
Denmark	27.18	33.70	47.54	49.71
Finland	49.47	68.61	60.55	82.11
Germany	3.44	4.03	4.73	5.17
Iceland	83.96	119.57	114.05	123.91
Israel	25.10	34.01	42.80	48.94
Netherlands	102.61	121.72	112.72	128.51
Switzerland	102.45	117.02	101.15	113.72
United Kingdom	72.00	78.63	64.29	88.68
United States	71.51	74.84	57.92	72.67

Source : OECD Global Pension Statistics.

Thanks to such a growth, not only will PF grant a significant share of the old-age retirement income, but they are currently playing as important institutional investors in most of the OECD countries. For example, the share of assets managed by occupational PF as a percentage of GDP in the last decade has grown from 15% to 31%, despite in the same period two intense crises have affected the financial markets of these economies. Given such an unprecedented scenario, the analysis of the effects of the aforementioned trend on financial markets is a crucial issue.

Earlier literature has highlighted that PF can be beneficial to financial development [1] through different channels: 1) PF long term planning horizon favors more efficient and innovative investment opportunities (Vittas 1996; Meng and Pfau 2010; Rocholl and Niggemann 2010; Davis 2011); as for developing economies, see Catalan et al. (2000); Impavido and Musalem (2000); Walker and Lefort (2002); Impavido et al. (2002). 2) PF may stimulate both private and national savings (Schmidt-Hebbel 1998; Kohl and O'brien 1998; James 1998; Bailliu and Reisen 1998; Murphy and Musalem 2004; Rezk et al. 2009; Antón et al. 2011) 3) PF may boost economic growth via improved corporate performance[2] (Myners and Britain 2002; Clark and Hebb 2003; Coronado et al. 2003) and improve the performance of firms (Guercio and Hawkins 1999) ; 4) PF can increase financial market efficiency by lowering asset price volatility.

The analysis of the last channel is the focus of our paper. The latter argument is supported in pioneering theoretical works such as Friedman (1953) who argues that the role of rational speculators is to stabilize asset prices. Later, Fama (1965) argues that although heterogeneous agents can trade irrationally due to poor information processing, the presence of sophisticated and well informed institutional investors could help eliminate huge disparities in the deviation of equity prices from their fundamentals. By the same token, later contributions by Chopra et al. (1992); Aggarwal and Rao (1990); Daigler and Wiley (1999); Brennan (2004); Kaniel et al. (2008) argue that institutional investors are more likely to behave rationally in that they are less sensitive to noise and fads. According to such a view, institutional investors are depicted as smart money investors that stabilize asset prices by offsetting the irrational trades of individual investors.

Other studies by Cohen (1998) and Dennis and Strickland (2002) document that institutions and individuals differ in their trading behaviors due to their difference in information gathering and processing of available information. In fact, they argue that institutional investors can help financial markets restore the long term equilibrium by avoiding huge volatility in the markets. Further, empirical evidence is provided by Faugere and Shawky (2003) who investigate the differences in the holdings of institutional investors relative to individual

[1]We recall here that several authors have produced evidence of the fact that financial development can trigger economic growth. For theoretical studies see Bencivenga and Smith (1991); Obstfeld (1995); horizontal cross analysis includes (King and Levine (1993); Levine and Zervos (1998); Levine (1997); Beck and Levine (2004); international analysis comprises studies by Rajan and Zingales (1998); Demirgüç-Kunt and Maksimovic (1998).

[2]A contradicting opinion has been raised by a few reporting that institutional owners are largely ineffective as monitors (Wahal 1996; Gillan and Starks 2000) and do not enhance shareholder value by monitoring firms. Some studies also find that institutional shareholders reduce firm performance either because they lack adequate monitoring skills or because their objectives conflict with value maximization See Carleton et al. (2002); Woidtke (2002).

investors when the Nasdaq Composite index fell 46.23% in year 2000. They find the evidence that during that market decline, institutional investors held stocks with less return volatility than individual investors. This argument is further accepted in the works looking at the relationship between noise trading and market efficiency: according to such works, the fact that risk aversion keeps rational speculators (such as PF) from taking large arbitrage positions can avoid any situation in which noise traders produce huge swings in the asset prices (Figlewski 1979; Kyle 1985; Campbell and Kyle 1993).

Finally, other authors claim that PF can stabilize the market because they are governed by prudent man rules[3](Arbel et al. 1983; Badrinath et al. 1989), aiding in accumulating less risky stocks thus indirectly reducing the overall volatility in the equity markets.

Summarizing, according to this view, lower levels of noise trading and/or the stabilizing behavior of institutional investors should result in lower volatility for those securities in which the presence of PF is predominant.

On the other hand, there are several reasons to suspect that markets dominated by institutional investors such as PF may exhibit larger return volatilities. First, securities that display greater volatility may attract institutional investors, in that the latter might view riskier securities as more likely than other stocks to outperform market benchmarks. Institutional investors like PF tend to trade in larger volumes than individual investors, which may induce greater volatility in the market (Kothare and Laux 1995; Falkenstein 1995; Gompers and Metrick 2001; Ang and Maddaloni 2005; Gabaix et al. 2006). In addition, the program trading employed by most of the institutional investors, including PF, could pave way for higher volatility.

Finally, PF may engage in positive feedback trading (Klemkosky 1977; De Long et al. 1990) and herding behavior (Nofsinger and Sias 1999; Sias 2004) due to the close-knit nature of the institutional investor community, which might exacerbate price movements and increase volatility.[4]

From this preliminary discussion one can understand the difficulty to draw a clear-cut line in the existing theoretical debate. In fact, the existing empirical studies at both micro and macro level produce mixed results. The present study aims at providing new empirical evidence as to whether investments of PF in stocks and equities could dampen stock market

[3]The prudent man standard could be summarized according to one or a combination of the following three fundamental approaches see Badrinath et al. 1989 :- 1) Buy and sell as others do in similar circumstances. 2) Buy and sell from an approved universe of investments (such as those listed in the Trust Fund Investment Act). 3) Buy and sell at the level at which the trust beneficiaries feel comfortable. Prudent man rules direct institution to invest a larger proportion of their holdings in prudent stocks. Age, low volatility, and stable dividends have been used in past studies as indicators of prudence (Smith; 1996).

[4]However, herding and positive feedback trading of better-informed investors do not necessarily destabilize stock prices if such strategies bring the price closer to fundamentals. For theoretical studies see Scharfstein and Stein (1990); Froot et al. (1992) and empirical studies include Lakonishok et al. (1992); Sias (1996); Cai and Zheng (2004); Burch and Swaminathan (2002); Hirshleifer et al. (1994); Wermer (1999); Wylie (2005).

volatility, thus promoting the efficiency of financial markets. In this work we focus on a panel of 34 OECD countries, from year 2000 to 2010.

The work is organized as follows: Section 2 reviews the related literature on the role of PF on financial market volatility. Section 3 describes the dataset used in the empirical analysis. Section 4 presents the estimated empirical models and discusses their respective results. Section 5 concludes.

2 Pension funds and financial market volatility: Related literature

The literature on the relationship between PF and financial market volatility has been intensely flourishing in the last two decades, with a particular focus on micro-level analysis and the US[5]market. However, in this section we focus only on the works specifically dealing with the role of PF.

For example, Lakonishok et al. (1992) examine the impact of PF on stock prices in United States. They investigate the holdings of 769 US PF and conclude that PF herding and positive feedback trading in large stocks is very modest. Though they have evidence of positive feedback trading for smaller stocks, however, the latter did not have destabilizing influence on stock prices. Moreover, the authors find that PF managers do not herd except for smaller stocks, where there is a slight degree of herding.

Jones et al. (1999) have investigated the relationship between stock prices and different types of institutions in the United States using quarterly data from 1984 to 1993. They find that all institutions are engaged in positive feedback trading. However there was no evidence of institutions destabilizing equity prices. The authors report that PF managers act as feedback traders especially on the buy side and mostly in small stocks with a high past performance.

Different conclusions are reached by Dennis and Strickland (2002) on the linkage between returns and aggregated and segregated institutional ownership in United States. By using the segregated data on mutual funds and PF, the paper shows that both funds move in the direction of the market with positive feedback herding behavior, particularly mutual funds. Hence, they conclude that, firstly, institutions herd together and trade with the momentum of the market on large market movement days. In short they conclude that the consequence of this behavior is that, at least in the short term, these institutions contribute to market

[5]A number of works have also analysed the impact of institutional investors on financial market volatility. Early studies find negative relation between volatility and institutional trading for the U.S. and for some other developed markets (Grier and Albin 1973; Reilly 1977; Reilly and Wachowicz Jr 1979; Arbel et al. 1983) while others gave mixed results (Sias 1996; Brown et al. 1996; Cohen et al. 2002; Dennis and Strickland 2002). For more recent works, see Zhou and Peng (2007); Li and Wang (2010) for China, Wermer (1999) and Rubin and Smith (2009) for United States and Azzam (2010) for Egypt.

volatility[6]

Finally, Lipson and Puckett (2007) revisit the issue of herding behavior for the US market and find that there is a "negative contemporaneous trading"[7] behavior of institutions using daily institutional trade executions for 716 institutional investors (90 money managers and 620 pension plan sponsors) on large market movement days during the period from 1999 to 2003.

As for studies of other countries, Voronkova and Bohl (2005) contribute to the literature on institutional herding and feedback trading by analyzing the investment behavior of PF on the Polish stock market. The application of the measure suggested by Lakonishok et al. (1992) enables the authors to compare the degree of herding and feedback trading between the Polish and developed stock markets. The estimated values of herding and positive feedback trading measures for Polish PF are considerably higher than the corresponding values reported for mature markets. This finding is primarily attributed to a stringent investment regulation and high market concentration. In short, trading by PF exerts significant influence on the future stock prices.

Further, Bohl et al. (2009) studies the volatility behavior of stock returns prior to and after the first transfer of money to the PF on 1999 in Poland. Using a Markov-switching-GARCH analysis they provide empirical evidence to the hypothesis that the PF investors in Poland reduced stock market volatility. In short, the increase of institutional ownership (PF) has temporarily changed the volatility structure of aggregate stock returns. Secondly, PF in Poland reduced stock market volatility.

Research on the macro front, which is the approach we follow in the present paper, is very embryonic and limited to few markets. Walker and Lefort (2002) have carried out a panel study for 33 emerging markets and find a positive link between pension reforms enhancing PF and capital market development. The results show that regardless of the indicator used, PF importance significantly decreases the average dividend yield and increases price to book ratios. The authors also find a negative and statistically significant relationship between market volatility and growth of PF assets. On the other hand, Davis and Hu (2004) find that in the G-7 countries, the share of institutional investors in total equities has a positive effect on equity price volatility. Similar results are obtained by Hu (2006) who empirically explores the impact of PF on market volatility, equity prices, government and corporate bonds for a panel of 24 countries. The data set used for the study covers 16 OECD countries

[6] This empirical result is in line with the theoretical argument of unintentional herding by Scharfstein and Stein (1990) and Froot et al. (1992), who argue that institutions focus on short horizons and ignore valuable information which have long term impact on stock prices. Therefore they mimic other institutional investors in the short run.

[7] This expression points to the fact that an increase in the investment of institutional investors in stocks and equities precedes a fall in volatility of stocks and equities.

and 8 emerging market economies for a time period from 1960 to 2004. The results supports Davis and Hu (2004) and finds a significant positive relation between PF assets and market volatility.

As mentioned, our paper follows the macro-approach and aims at adding new evidence on the relationship between PF investments in stocks and stock market volatility. Differently from previous works we focus on the panel of the whole set of OECD countries, from year 2000 to 2010.

3 Data Description

The countries comprised in the panel include Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. The data is drawn from OECD database and World Bank database.

The specific time span we focus on goes from 2000 to 2010 and is due to data availability. This period has witnessed a rich dynamics of PF, although at different growth rates among countries, which may allow us to have enough variability to get robust estimates.

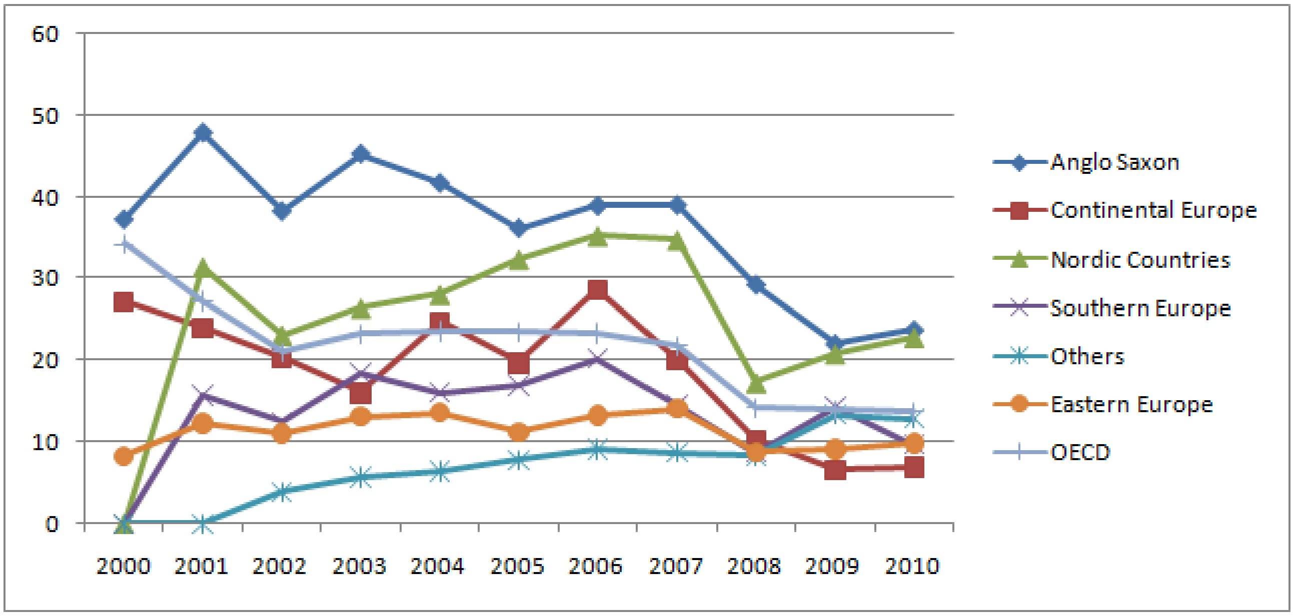
In order to examine and quantify the effect of PF on stock market volatility, we employ, as explanatory variable capturing such an effect, the ratio between PF assets invested in shares and total PF assets at a country level[8]. We have a total of 374 observations on every variable.

Figure 1 shows the trend in the investments of PF in stocks among selected OECD countries divided into seven groups - Anglo Saxon, Continental Europe, Southern Europe and Nordic Countries, Eastern Europe, Others and OECD average from 2000 to 2010. From the picture two features emerge: First, Anglo Saxon and Continental Europe economies are the ones in which PF predominantly invest in stocks. Second, the trend of the share of PF assets invested is decreasing at the tails of the time interval, and decreasing within it.

The shape of PF investments through time reveals that PF have very plausibly adjusted their portfolios composition according to the trends of financial markets, which have been characterized by two crises: 2001 and 2007. Overall, the average share of stocks hold by PF in the period under investigation has gradually decreased from 34.67 percent in 2000 to

[8]PF investments in financial market are broadly categorized into investments in Bills and Bonds, Mutual Funds, Currency and Deposits, Shares and Equities, Land and Buildings and Other Investments. Among them, our study concentrates on the Investments in shares and equities which along with Bills and Bonds and Mutual funds form a significant portion of the total investments of PF in OECD markets.

Figure 1: Trend of the share of PF assets invested in stocks across all OECD countries for the time period 2000 - 2010.



Note: The Y axis shows the share of PF assets invested in stocks and X axis shows the years (2000-2010). The Southern Europe includes: Italy, Spain, Portugal and Greece. The Nordic countries include: Denmark, Finland, Iceland, Norway and Sweden. The Continental Europe include: Austria, Belgium, Germany, Luxembourg, Netherlands and Switzerland. The Anglo Saxon countries include: Australia, Canada, Ireland, New Zealand, United Kingdom and United States. The Eastern Europe include: Czech Republic, Hungary, Slovenia, Slovak Republic, Poland and Estonia. Others include: Chile, Israel, Mexico, Japan, Korea and Turkey.
Source: OECD Global Pension Statistics, authors' calculation.

13.95 percent in 2010. The uncertain (or, better, prudent) trend of PF behavior can also be recognized by the growth rates depicted in Figure 2 in selected OECD countries.[9]

As for market volatility, in our empirical model we define it as the 12-month-annualized volatility of stocks for each OECD country, that is, the annualized standard deviation of monthly stock prices. We need to annualize the volatility because all other variables are available on a yearly basis.

The annualised volatility σ_T for time horizon T in years is expressed as:

$\sigma_T = \sigma\sqrt{t}$

where,

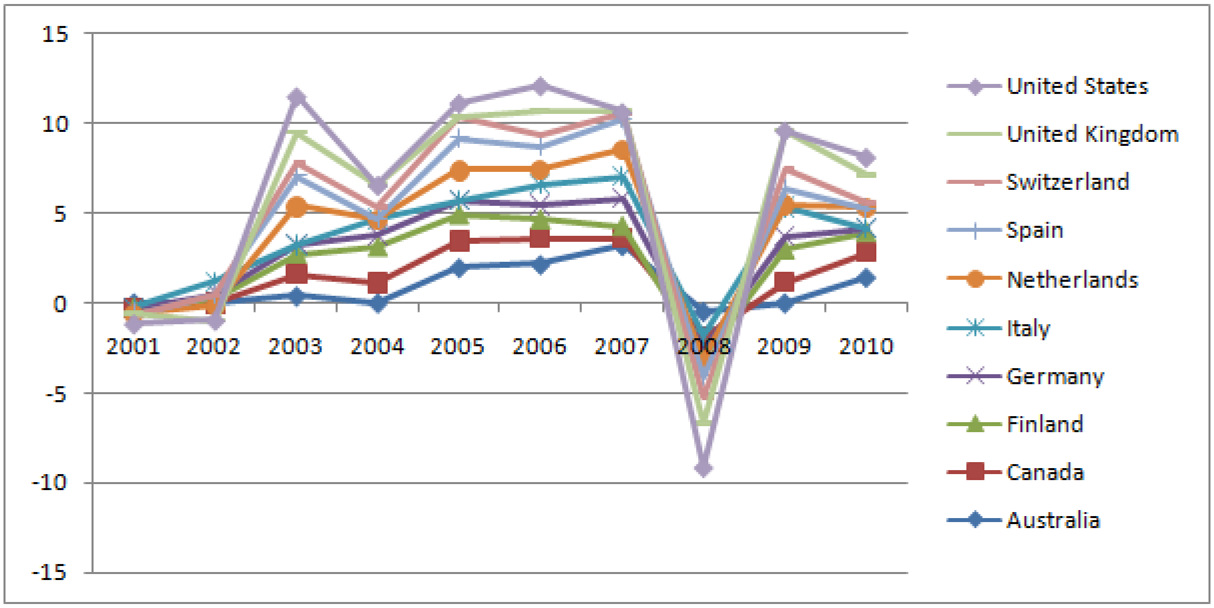
σ_T = Annualised Volatility

σ = Standard Deviation for a particular time period

t = Number of times (count) of such time periods in a year, in our case 12. Moreover, in our

[9] All the above mentioned economies have invested more than 25 percent of total assets in shares and equities.

Figure 2: Percentage change of the share of assets invested in stocks and equities by PF in selected countries from 2001 to 2010.



Note:The Y axis shows the percentage change of the share of PF assets invested in stocks and X axis shows the years (2001-2010). Data on France is not available for most of the period.
Source: OECD Global Pension Statistics, authors' calculation.

estimations we take logs because volatility cannot be negative.

Another measure of the overall market volatility we employ in our analysis is the (logs of) average volatility of all OECD economies in each year, in order to take care of the economic cycles. In Table 2, we report a dummy variable which takes value 1 if the observed variability of stocks in a country at any year is below the OECD average and 0 if this value lies above the average, respectively: we can notice that almost 60 percent of observations in each year lie below the overall mean volatility and 40 percent of observed countries lie above the average.

Table 2: Frequency and percentage of observations above and below the yearly average volatility of OECD countries (dummy variable: 0 if below, 1 if above the average), years 2000-2010.

Volatility	Frequency	Percentage
0	223	59.47
1	152	40.53
Total	374	100

Source : OECD Global Pension Statistics, authors' calculation.

Finally, Table 3 shows the main summary statistics of all the explanatory variables that we use in our empirical analysis, that is the per-capita income in thousand USD as a general measure of economic country development, the annual inflation rate as an indicator of macroeconomic stability, and value of stocks trades at constant year 2000 prices in trillion USD as a measure of financial development.

Table 3: Descriptive Statistics of the variables included in the study.

Variable	Obs	Mean	Std	Min	Max
Volatility(VOL)	374	.172	0.088	0.049	0.943
Share of PF assets invested in stocks and equities %(SS)	361	17.1	0.16	0.00	66.29
Inflation%(IF)	374	3.317	4.979	-4.479	54.915
Per capita Income*(PCI)	374	28.365	11.12	9.053257	74.1438
Value of Stocks Traded**(ST)	374	1.387	5.171	0.000016	52.2454

** Per- capita Income measured in Thousand USD, **Value of stocks traded measured in trillion USD.*

Note that the share of PF assets invested in stocks varies between 0% and about 60%. This shows that OECD countries are marked by heterogeneous behavior in investment policies, which are also found to be changing over time. The countries in which the share of PF investments in stocks and equities is zero include Estonia, France, Japan, Greece, New-Zealand and Turkey.[10]

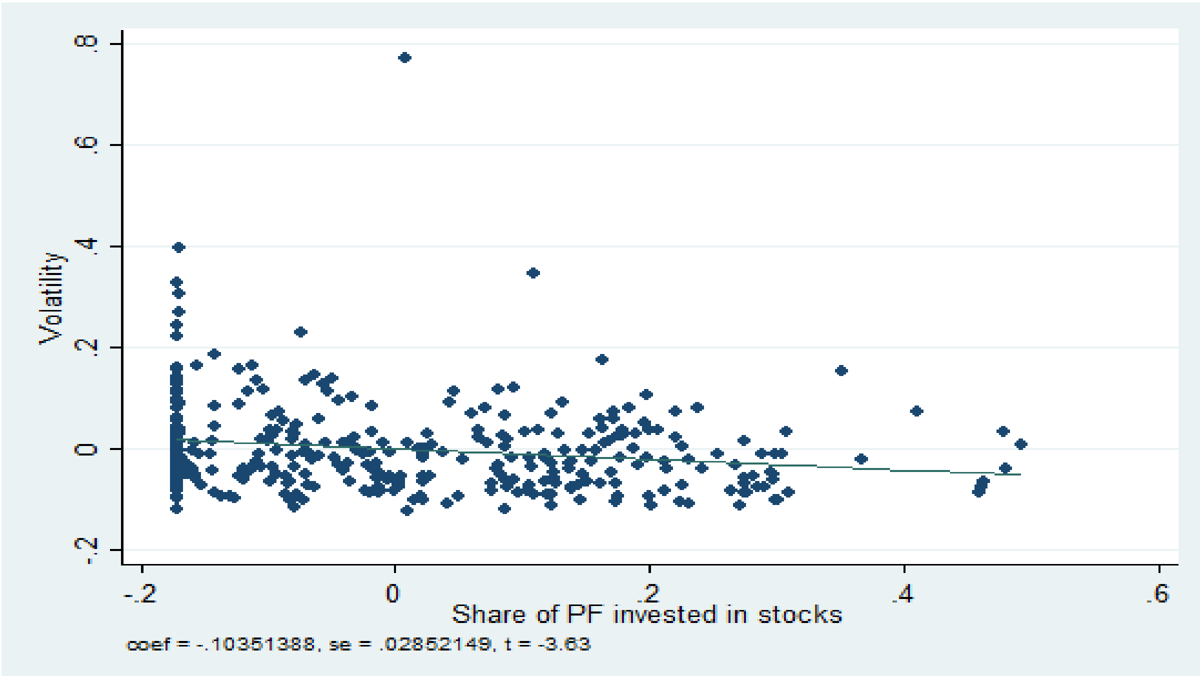
4 Empirical models

In this section, we present the empirical models adopted in the study and the results.

Preliminarily, we resort to an added variable plot, depicted in Figure 3. The added variable plot is based on two residual series. The first series contains the residuals from the regression of the variable share of PF assets invested in stocks on all other independent variables presented in Table 3, whereas the second series contains the residuals from the regression of volatility of stock prices on all other independent variables except share of PF assets invested in stocks. Therefore, the first series represents the part of X_1 (here, share of PF assets invested in stocks) that cannot be linearly related to those other regressors, whereas second series represents the information in y (here, volatility of stocks) that is not explained by all other regressors (excluding X_1).

[10]Among them, Greece and Turkey showed zero share of PF invested in stocks till 2007 and 2008, respectively.

Figure 3: Added Variable Plot of Share of PF assets invested in stocks and stock market volatility in OECD markets.



Source: OECD Global Pension Statistics.

The strength of the relationship between the two variables is evident from Figure 3. The slope of the least squares line through this scatter of points representing the marginal value of the variable share of PF assets invested in stocks is negative and significantly different from zero. The t statistics of -3.63, reported in the figure (identical to those from a simple OLS regression), suggests that the least squares line has a slope significantly different from zero. The outlying values are evident where low values of share of PF invested in stocks are associated with volatility much higher than those predicted by the model.

Tests for Endogeneity

The question of endogeneity is also addressed in the study, where the variable share of pension funds invested in stocks (SS) is suspected to be endogenous. As a first step we undertake a Hausman test. As a general rule, when a variable is endogenous, it will be correlated with the disturbance term, hence violating the GM assumptions and making our OLS estimates biased.

So the first step, before using a 2SLS, or an IV approach is to confirm the existence of endogeneity. Recall that the 2SLS estimator is less efficient than OLS when the explanatory variables are exogenous (i.e., uncorrelated with the error term in the structural model). The test for strict exogeneity of SS_{it} developed by Hausman (1978) is used in the structural model.

In the first stage, we estimate the equation using OLS

$$SS_{it} = \alpha_i+\beta_1 Z_{it}+\beta_2\sigma_t^{all}+ \beta_3 ST_{it} + \beta_4 IF_{it} +\beta_5 PCI_{it} +v_2 \tag{1}$$

Here, SS_{it} (share of pension assets invested in stocks and equities) is the suspected endogenous variable. Z_{it} is the list of instruments which is used in the equation (here we use only one instrument namely [11] ratio of secondary and tertiary education to the total population). The coefficients (β_{2i}, $\beta_{3i,t}$ .....$\beta_{5i,t}$) are the list of exogenous independent variables and v_2 is the residual term.
Secondly we obtain the residuals.

$$\hat{v_2} = SS_{it} \text{-}\hat{\alpha_i}\text{-}\hat{\beta}_1\ Z_{it}\text{-}\hat{\beta}_2\ \sigma_t^{all}\text{-}\hat{\beta}_3 ST_{it}\text{-}\hat{\beta}_4 IF_{it}\text{-}\hat{\beta}_5 PCI_{it} \tag{2}$$

We then estimate the structural model including the residuals

$$\log VOL_{it} = \alpha_i + +\beta_1 SS_{it}+\beta_2\sigma_t^{all}+ \beta_3 ST_{it} + \beta_4 IF_{it} +\beta_5 PCI_{it} + \delta\hat{v_2} \tag{3}$$

The Hausman approach tests the null hypothesis H_0: $\delta = 0$. If this is true then there is no issue of endogeneity and therefore using IV is less efficient and therefore will be biased. The instruments used in the analysis posses the property of significant correlation with the key independent variable, but not with the main equation dependent variable.

After analysing each instrument and combinations of the instruments, the results yielded that there is no endogeneity in the model, with every regression exercise confirming that $\delta = 0$. This was further understood as we received biased results while performing the 2SLS regression. Though the instruments displayed moderate to high strength (which is a prerequisite for unbiased IV estimate) analysed using the F test and Sargan test, the coefficients which showed significant coefficient in the Random effects and Prais Winsten model, displayed insignificant values while performing a 2SLS. This further validates our argument that there is no endogeneity. The results of the exercise are displayed in Appendix A2.

We now turn to the empirical models. The first empirical model is a random effects

[11] Saving rate, Dependency rate, Activity rate, Ratio of Public pension expenditure to GDP, Pension fund assets to GDP, ratio of secondary and tertiary education to the total population, lag of share of PF invested in stocks are also analysed. We also took the lags and the powers of the instruments of the variables above, without dropping the results.

model followed by a Prais-Winsten model which takes into account autocorrelation and heteroscedasticity embedded in the data. A further examination of the data is carried out using a binary logit and probit model. The detailed methodology and results are discussed in the following section.

4.1 Empirical Model 1: Random effects/Prais-Winsten method

The empirical model we estimate has the following specification:

$$y_{it} = \alpha_i + x'_{it}\beta_i + \epsilon_{it} \tag{4}$$

i = 1,... N, t=1,.... T

where, y_{it} is the dependent variable, i is the cross-sectional dimension for individual countries, t is the time series dimension of the data, α_i denotes country specific intercept, β_i = (β_{1i}, $\beta_{2i,t}$ .....β_{Mi}), is the vector of coefficient to be estimated, $x_{i,t}$ = ($x_{1i,t}$, $x_{2i,t}$, ... $x_{Mi,t}$) is the vector of explanatory variables, m= 1,..... M where M is the total number of regressors, ϵ_{it} is the error term. Therefore, based on equation (1) the following specification equation is estimated:

$$\log VOL_{it} = \alpha_i + \beta_1 SS_{it} + \beta_2 \sigma_t^{all} + \beta_3 ST_{it} + \beta_4 IF_{it} + \beta_5 PCI_{it} + \epsilon_{it} \tag{5}$$

where VOL represents the estimated 12 month annualized rolling volatility, SS is the share of PF assets in stocks. We expect β_1 to be negative (i.e.share of PF assets invested in shares reduces volatility). A set of concurrent conditions are included as control variables σ_t^{all} represents the average volatility of all OECD countries, and we expect β_2 to be positive (volatility is contagious). The value of stocks traded in the market ST, is a proxy to measure the depth of the stock market and is likely to reduce market volatility while the annual inflation rate, IF is a proxy for macroeconomic stability and β_4 is expected to have a positive effect. Per capita income denoted by PCI, is a general measure of countries development. We now present a series of tests that help us choose the exact specification of the model to be estimated.

Fixed vs Random Effects: Hausman Test

We first employ the Hausman specification test for testing the null hypothesis that there is no correlation between the composite error and explanatory variables. The results of the test show that there is no evidence to reject the null hypothesis and hence the random effect model is applicable[12]. We also perform Bruesh-Pagan Lagrange Multiplier test which helps to decide between random effects regression and a simple OLS regression.[13] The results are shown in Appendix A3.

Cross-Sectional Dependence among Countries

The random effects model requires strong assumptions regarding error terms, autocorrelation, and heteroscedasticity. The probability of cross sectional dependence of country level data as compared to individuals and firms is generally low. However if present in cross country panels due to unobserved common shocks, cross sectional dependence can cause inconsistency in the estimated parameters (see Driscoll and Kraay 1998). A semi parametric test proposed by Friedman (1953) and Pesaran (2004) for panels with N > T has been employed and the results suggest that there is no evidence of cross sectional dependence in the model (the test results are provided in Appendix A4).

Test for Heteroscedasticity and Serial Correlation

To test the null hypothesis of no first-order serial correlation in the residuals, we use the Baltagi-Wu locally best invariant test statistics. The Baltagi LBI statistic of 1.67 and the Bhargava et al. (1982) Durbin-Watson statistic for zero first order serial correlation of 1.53 reject the null hypothesis of no first order serial correlation (See Appendix A5). The rejection of the null hypothesis of no serial correlation indicates the need to correct the standard errors for serial correlation. Moreover, we perform a Wald Test for heteroscedasticity and the results suggest that there is evidence of heteroscedasticity (See Appendix A6).

Prais-Winsten method

If the error terms exhibit heteroscedasticity and autocorrelation, it has to be decided which panel data approach to choose: individual effects model or panel corrected standard errors method. In the presence of autocorrelation and heteroscedasticity, fixed and random effects estimators are inefficient and biased and therefore we require a methodology which corrects the standard errors of the panel in order to solve these issues (i.e. the problem of heteroscedasticity, autocorrelation and correlation across panels if present). Therefore, we estimate the parameters of the model by Prais-Winsten method and then adjust the standard errors for the panel data as suggested by Beck and Katz (1995). This approach is used when the residuals are modelled as a first order auto regression or AR (1) process.

$$\epsilon_{it} = \rho\epsilon_{it-1}+\eta_{it} \tag{6}$$

[12] The Hausman test is a kind of Wald (χ^2) test with k-1 degrees of freedom (where k = number of regressors) on the difference matrix between the variance-covariance of the Least Square Dummy Variable with that of the Random Effects model.

[13] The null hypothesis in the Bruesh-Pagan LM test is that variances across entities are zero, i.e., no significant difference across units (i.e. no panel effect). Here we reject the null and conclude that random effects is appropriate.

where η_{it} are independent and identically distributed with mean 0 and ρ is the autocorrelation parameter with order 1.
The model is estimated by Feasible Generalised Least Squares (FGLS). The method coined out by first estimating equation (4) by OLS. The residuals from this estimation is used to estimate the ρ in equation (6). The estimate of ρ is used to transform the data and this transformed model is again estimated using OLS. The estimator by Prais and Winsten (1954) transforms the data as follows in Appendix A7.

4.1.1 Results of the Random effects and Prais-Winsten models.

Table 4: Random Effects Model Estimation. Standard errors are given in brackets.

Variable	Coefficient
Share of PF assets invested in stocks and equities (%)	**-0.0681****
	(0.02)
Average Volatility	**0.93*****
	(0.08)
Value of Stocks Traded	**-0.009****
	(0.00)
Inflation	**0.004*****
	(0.008)
Per Capita Income	0.0009
	(0.0005)
Constant	-0.016
R-squared Within	0.51
R-squared Between	0.37
R-squared Overall	0.48
Joint Significance Test for all	(χ^2) (5)=**200.04*****

*** Significant at a level of 1%, ** Significant at a level of 5 %, * Significant at a level of 10 %

As for the results from the random effects model, preliminarily it is worth recalling that the interpretation of the coefficients is somehow tricky since the latter include both the within entity and between entity effects. However, by observing the p values, we can note that all coefficients of the independent variables except for per capita income are significant. The joint significance test (χ^2) with a significant p value suggests that all coefficients are significant. Among the coefficients, we note that the one associated with the share of PF assets is negative, as expected, confirming that PF investments in the markets may contribute to enhance the efficiency of the latter. The coefficient is significant at 5% level.

The inflation rate, which is a proxy for macroeconomic stability, shows a positive effect and the coefficient is significant at 1% level. The theoretical argument that larger financial markets are more liquid and hence may possibly reduce the volatility of stock prices is also confirmed by the fact that the coefficient of the value of stocks traded is negative, at a 5% level. Finally, the per capita income employed as a proxy to take care of cross country differences has no effect on volatility of stocks.[14] The results of the random effect model and the Prais Winsten approach are reported in Table 4 and Table 5, respectively.

Table 5: Estimation results using the Prais-Winsten method. Standard errors are given in brackets.

Variable	Coefficient
Share of PF assets invested in stocks and equities %	**-0.060*****
	(0.015)
Average Volatility	**0.93*****
	(0.027)
Value of Stocks Traded	**-0.001*****
	(0.0003)
Inflation	**0.005*****
	(0.0008)
Per Capita Income	0.0008
	(0.0006)
Constant	-0.016
R-squared Within	0.51
Joint Significance Test for all	(χ^2) (4)=**1612.63*****

*** Significant at a level of 1%, ** Significant at a level of 5 %, * Significant at a level of 10 %

By comparing the random effects model results and the ones stemming from the Prais-Winsten transformation, we can notice that we do not observe a marked difference neither in the sign of the coefficients nor in the value of the estimated coefficients and their respective p values. However, we know that the random effects estimation is biased due to the presence of heteroscedasticity and serial correlation. By looking at Table 5, we observe that the coefficients of average volatility, inflation, share of PF assets in stocks and value of stocks traded are statistically significant. The joint significance level (χ^2) also shows significance of all co-

[14]We also use some regressions by using variables such as GDP growth rate and Industrial Production Index of OECD countries as a substitute for the per capita income variable. However the results did not change.

efficients in the model. As expected, the coefficient value of average volatility is positive and significant at 1% level, thus confirming that overall volatility is contagious. The coefficient value of share of PF assets invested in stocks is negative and significant at 1 percent level, showing that PF asset growth in equities leads to less volatility in stock markets.

All in all, the results provided so far confirm the positive effect of PF investments in stocks on financial markets efficiency. On the other hand, per capita income does not seem to have a significant role in explaining the volatility in stock markets. The relatively high degree homogeneity of OECD countries under the study could be sought as a reason for such a finding.

However, we also observe that the value of the coefficient of the average volatility seems to overshadow the other coefficients. In fact, the value of average volatility coefficient using Prais- Winsten method is 0.93 and thus appears to be the most significant variable influencing volatility of stocks. This result is expected, as there is a lot of interdependence between OECD countries markets and moreover volatility is intrinsically contagious, such that the volatility in one country certainly will have influence on the volatility experienced by others, possibly due to high financial networks among these well-developed financial markets.

In order to purge out the effect of the overall variability from the model, we resort to a binary model which tries to explain the presence of differential variability over the cycle in OECD countries, that is the level of volatility beyond the overall average financial markets value.

4.2 Empirical Model 2: Binary Choice - Probit Model with dependent variable taking value 1 (if stock volatility is greater than average volatility) or 0 otherwise.

The variable that we have now at the LHS of the empirical model is a dummy variable that is built as follows:

y_{it} = [1 if volatility of a country i is bigger than the average volatility observed 0 if volatility of a country i lower than the average volatility observed.]

Since binary choice models are stronger in cases where the independent variables are discrete (See Wooldridge 2001, chp 16), we decided to build a dummy variable D_{it} that takes value 1 if PF invested in stocks and 0 otherwise. Out of the total data points, 23.9% are referred to countries in which PF have not invested in stocks over the time period under consideration. The other variables are the same used in the previous models. Finally, under assumption that ϵ is N(0,1), we can estimate the probit model and the results are shown in Table 6. We perform a likelihood ratio (L-R test) in order to check for variables relevance. The null hypothesis is that all coefficients except that of the intercept are equal to zero. Here the LR $(\chi^2)(3)$= 12.37 with prob $>(\chi^2)$ =0.00. Therefore the hypothesis that all coefficients are equal to zero can be rejected at 1 % level of significance.

Table 6: Estimated Coefficients, Standard Error and P-values from the Probit Regression and their respective marginal effects computed.

Probit estimation		Marginal effects of Probit Estimation
Variable	Coefficient	Coefficient
Dummy*=1 if PF invested in stocks, 0 otherwise	**-0.437*** **	**-0.169*** **
	(0.165)	(0.064)
Inflation	**0.057** **	**0.021***
	(0.030)	(0.011)
Per- capita Income	0.004	0.001
	(0.006)	(0.002)
Value of Stocks traded	**- 0.162** **	**-0.61** **
	(0.069)	(0.024)
Constant	-0.104	
	(0.027)	

*** Significant at a level of 1%, ** Significant at a level of 5 %, * Significant at a level of 10 %

The most interesting result we get is that the dummy is now significant at 1% level. The sign of the coefficient is negative which confirms the negative relation between investment of PF in stocks and volatility of financial markets.

Moreover, as expected and in line with the results of the random effects model and Prais-Winsten method, the inflation rate coefficients have the expected signs and are significant at 5% level, while the value of stocks traded is significant at 6% level showing a negative sign as expected. However the coefficient of per capita income remains insignificant in this model (we still add this variables as it could catch any country differences; see also Walker and Lefort 2002). In order to better quantify the influence of the variables on the right hand side on the probability that y_{it} takes value 1, we look at the marginal effects of the right hand side variables. Since we have both continuous variables like inflation rate, value of stocks traded, per capita income and the dummy variable we can use two different methods to compute the marginal effects.

Continuous Variable

Average Marginal Effects = 1/n $\sum_{i=1}^{n}$ Ω ($\bar{X}_i$' β)β

Dummy Variable

Average Marginal effect = 1/n $\sum_{i=1}^{n}$ [Φ(X_i' $\beta|x_i^k$ =1)]− [Φ(X_i' $\beta|x_i^k$ =0)]

According to our findings, a 1% change in the inflation rate changes the probability that y_{it} takes value 1 (countries having a higher volatility than the average volatility) by 2.1%. The most interesting result is with respect to the dummy variable (whether in the country PF have invested in the stock market). The probability of volatility to take value 0 is around 17% when the dummy variable shows value 1. By this result we further confirm and quantify the negative relationship between investments of PF in stocks and stocks return volatility. The 1% change in the unit measurement of stocks traded changes the probability that y_{it} takes value 1 by 6.1%.

4.3 Empirical Model 3: Binary Logistic Regression where dependent variable taking value 1 (if stock volatility is greater than average volatility) or 0 otherwise.

In this section, we also check the results using the logit model which does not require the assumption of normal distribution of error terms. All the variables remain the same as those of the probit model (recall that the logit model is assumed to have a standardized logistic with known variance equal to $\pi^2/3$).

The results of the logistic regression and the marginal effects are presented in Table 7. The likelihood chi square of 36.86 with p value 0.000 shows that our model as a whole fits significantly better than a model with no predictors. While looking at the significance and signs of coefficients, it can be seen that the results do not change much with respect to the probit model. Except for the variable per capita income, the other three important variables are significant and with expected signs.

Recall that the logistic regression coefficients give the change in the log odds [15] of the outcome for one unit increase in the predictor variable. As seen in probit regression, since beta coefficients do not have a direct interpretation we compute the marginal effects in the

[15] We recall that log (odds)= log (p/q) where p = probability for y of taking value 1/and q the probability that y = 0. Therefore, for example, one unit change in inflation rate provides 10% increase in the log odds of y_{it} taking value 1 versus y_{it} taking value 0 increases by 2.3 percent. Similarly for a change of dummy form 0 to 1 (i.e. whether the country has invested have invested in stocks or not), the log odds of y_{it} taking value 1 decreases by 0.17 percent.

Table 7: Estimated Coefficients, Standard Errors and p-values from Logistic Regression and their respective marginal effects computed.

Logit estimation		Marginal effects of Logit Estimation
Variable	Coefficient	Coefficient
Dummy*=1 if PF invested in stocks, 0 otherwise	**- 0.686*** **	**-0.164** **
	(0.270)	(0.065)
Inflation	**0.095** **	**0.022** **
	(0.048)	(0.011)
Per- capita Income	0.008	0.001
	(0.010)	(0.002)
Value of Stocks traded	**- 0.276** **	**-0.064** **
	(0.121)	(0.026)
Constant	-0.189	
	(0.435)	

*** Significant at a level of 1%, ** Significant at a level of 5 %, * Significant at a level of 10 %

similar way as we performed in the probit model.

A change in the inflation rate changes the probability that y_{it} takes value 1 (countries having a higher volatility than the average volatility) by 2.2%. Similarly an increase in the value of stocks traded in the market decreases the probability that y_{it} takes the value 1 by 6.4%. As for the dummy variable concerning the presence of PF in the stock markets, we can see that probability of volatility to take value 0 (i.e. volatility of the respective country to be less than the average volatility) is around 16.4% when the dummy variable takes value 1 (i.e. the country has PF that invested in stocks). By this result we further confirm the negative relationship between PF investment in stocks and stock return volatility in the financial markets.

5 Conclusions

The pension fund industry has witnessed a significant growth in the past few years and this phenomenal growth trend is likely to continue for the coming decades. In this background, we studied the impact of investments of pension funds in stocks on stock market volatility. This paper contributes to the current literature by looking at macro effects of pension funds assets on stock market efficiency.

Using panel data of 34 OECD countries from 2000 to 2010, we estimate the impact of pension fund assets invested in stocks and equities on stock market volatility by applying random effects panel model as well as Prais-Winsten regressions with panel-corrected standard errors and autoregressive errors. Our empirical findings using both models reveal that there is significant reduction in volatility of stock prices when the investment of pension funds in stock increases. This finding thus is consistent with other studies such as the one Walker and Lefort (2002) who find the same results with an emerging country database and using a different set of variables. However the methodology revealed that the coefficient of average volatility is very high and thus the latter emerges as the most significant variable influencing volatility of stocks. Hence, we also focus on the explanation of the amount of volatility observed in each country above the level of average volatility due to the business cycle.

For doing this we estimate both binary probit and logit models. The results of these models clearly show that the countries in which pension funds invested in stocks have higher probability of witnessing lower volatility than the average volatility. In the case of a probit the probability of volatility to take value 0 (i.e. volatility of the respective country to be less than the average volatility) is around 17 percent when the dummy variable shows value 1 (i.e. the country has pension funds that invested in the stocks), while in the case of logit the marginal effect is around 16.4 %. Hence, we can conclude that the presence of pension funds in the stock markets produces higher efficiency in the financial markets by reducing stock return volatility.

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Appendix A1: Share of Pension fund assets invested in stocks and equities among various country groups.

Year	Anglo Saxon	Continental Europe	Nordic Countries	Southern Europe	Eastern Europe	Others	OECD
2000	37.3	-	25.66	-	8.36	-	34.27
2001	47.93	24.09	32.93	15.67	12.35	-	27.3
2002	38.3	20.35	22.45	12.43	11.11	3.88	21.12
2003	45.34	16.12	25.38	11.05	13.1	5.66	23.32
2004	41.76	24.81	26.66	12.09	13.60	6.34	23.62
2005	36.22	19.76	31.88	12.8	11.28	7.74	23.59
2006	38.96	28.65	34.29	15.2	13.27	9.06	23.39
2007	39.05	20.06	34.88	14.61	14.08	8.71	21.82
2008	32.75	10.37	17.09	8.68	8.8	8.25	14.29
2009	26.42	6.72	20.61	11.48	9.12	13.25	13.9
2010	23.76	7.03	22.86	9.48	9.91	12.87	13.76

Source : OECD Global Pension Statistics, Author's Calculation.

Appendix A2: Test for Endogeneity. Standard errors are given in brackets.

Variable	Coefficient	Standard Error
Share of PF assets invested in stocks %	-0.030	(.043)
Average Volatility	**0.968*****	(0.099)
Value of Stocks Traded	**-0.002****	(0.000)
Per- capita Income	0.007	(0.008)
Residual	-0.058	(0.065)

Note: The instrument used is Ratio of secondary and tertiary education to the total population
*** Significant at a level of 1%, ** Significant at a level of 5 %, * Significant at a level of 10 %

Appendix A3: Hausman test

Variable	Fixed(b)	Random(B)	Difference(b-B)
Average Volatility	0 .917	0.930	-0.013
Share of Pension funds invested in stocks	-.0978	-.068	-.0296
Inflation	0.004	0.004	-0.0005
1ex] Per-capita Income	.002	0.00	0.001
Value of Stocks Traded	-0.0007	-0.0009	0.0002

where b refers to the model which is consistent under both null (H0) and alternative (Ha) hypothesis.
B refers to the model which is inconsistent under (Ha)and efficient under (H0).

$(\chi^2)(5)$=5.50, Prob>(χ^2) = 0.3577

Bruesch Pagan Lagrangian multiplier test for random effects

(χ^2) (34) = 35.29

Prob>(χ^2) = 0.000

Appendix A4: Tests for Cross sectional dependence

Pesaran's test of cross sectional independence = -0.259, Pr = 1.2042

Friedman's test of cross sectional independence = 13.221, Pr = 0.9992

Appendix A5: Test for first order serial correlation

Modified Bhargava et al Durbin Watson =1.5370

Baltagi -Wu-LBI =1.67

Appendix A6: Wald Test for Heteroscedasticity

Modified Wald test for group-wise heteroscedasticity in fixed effect regression model

(χ^2) (34) = 927.79

Prob>(χ^2) = 0.000

Appendix A7: Prais Winsten Transformation Formula

The transformation formula is provided in Wooldridge (2001). Panel Corrected Standard Errors (PCSE) using Prais-Winsten are calculated with the use of following formula: Var β^{PCSE} = $(X'X)^{-1}$ X' Ω X $(X'X)^{-1}$, where matrix X represents the explanatory variables, whereas is the covariance matrix for all error terms.

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